

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application Number : 09/938,669 Confirmation No.: 2508
Applicant : Jens PETERSEN
Filed : August 27, 2001
Title : POLYACRYLAMIDE HYDROGEL AS A SOFT TISSUE FILLER
ENDOPROSTHESIS
TC/Art Unit : 1615
Examiner: : Carlos A. Azpuru

Docket No. : 60117.000004
Customer No. : 21967

MAIL STOP AMENDMENT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

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Sir:

In accordance with 37 C.F.R. §§ 1.97 and 1.98, and in compliance with the duty of disclosure set forth in 37 C.F.R. § 1.56, Applicant submits attached Form PTO/SB/08B (modified) for consideration and requests the references cited therein be made of record by the U.S. Patent and Trademark Office in the above-captioned application.

Applicant respectfully points out that the submission of the listed references in this Information Disclosure Statement is not an admission that they are prior art or that they are material to patentability of any claims of the application. Also, the submission of this Information Disclosure Statement is not an indication that a search has been made by Applicant.

In accordance with 37 C.F.R. § 1.98(a)(2), a copy of each of the cited references is enclosed with this communication. In considering the cited references, it may be noted by the Examiner that certain of the references may contain markings, underlinings, and/or other notations. These markings, underlinings, and/or other notations are not to be construed as drawing the Examiner's attention either to selected parts or away from other parts of the cited references. Any such markings were either present on the copies of the cited references obtained

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Consideration of the foregoing plus the prompt return of a copy of the enclosed Form PTO/SB/08B with the Examiner's initials in the left column in accordance with M.P.E.P. § 609 are respectfully requested.

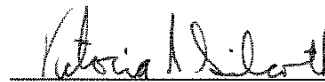
In accordance with 37 C.F.R. § 1.97(c)(2), this Information Disclosure Statement is believed to be submitted after the issuance of a first Office Action on the merits but before the mailing date of any action closing prosecution in the application. The Commissioner is authorized to charge the undersigned's Deposit Account No. 50-0206 the amount of \$180.00 in accordance with 37 C.F.R. § 1.17(p). It is respectfully submitted that no additional fees are required for consideration of this information. However, in the event that the USPTO determines that a variance exists between the amount authorized above and the amount due, the Commissioner is hereby authorized to debit or credit such variance to the undersigned's Deposit Account No. 50-0206.

Respectfully submitted,

HUNTON & WILLIAMS LLP

Dated: May 15, 2006

By:



Stanislaus Aksman
Registration No. 28,562

Victoria A. Silcott
Registration No. 57,443

Hunton & Williams LLP
Intellectual Property Department
1900 K Street, N.W.
Suite 1200
Washington, DC 20006
(202) 955-1500 (telephone)
(202) 778-2201 (facsimile)
SA/VAS/asc

Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT <i>(use as many sheets as necessary)</i>		Application Number	09/938,669
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		Art Unit	1615
		Examiner Name	Carlos A. Azpuru
Sheet	1 of 1	Attorney Docket Number	60117.000004

OTHER DOCUMENTS - NON-PATENT LITERATURE DOCUMENTS

*Examiner Initials	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published	TRANSLATION	
			YES	NO
	1.	Stevens, Malcolm P., Definitions, "Polymer Chemistry: An Introduction", Third Edition, Oxford University Press, Inc., Sect. 1.2, pgs. 6-10, 1999.	<input type="checkbox"/>	<input type="checkbox"/>
	2.	Lewis, Richard J., Sr., Olefin (alkene), "Hawley's Condensed Chemical Dictionary", Thirteenth Edition, John Wiley & Sons, Inc., pg. 819, 1997.	<input type="checkbox"/>	<input type="checkbox"/>
	3.	O'neil, Maryadele J., et al. (Eds.), Acrylamide, "The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals", Thirteenth Edition, Merck Research Laboratories, Merck & Co., Inc., Listing no. 131, pg. 128, 2001.	<input type="checkbox"/>	<input type="checkbox"/>
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THIRD EDITION

POLYMER CHEMISTRY

AN INTRODUCTION

Malcolm P. Stevens

University of Hartford

New York Oxford

OXFORD UNIVERSITY PRESS

1999

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the theories of Staudinger on a firm experimental basis and led to the commercial development of neoprene rubber and polyamide (nylon) fibers.¹¹

World War II led to significant advances in polymer chemistry, particularly with the development of synthetic rubber when the natural rubber-growing regions of the Far East became inaccessible to the Allies. Among the more significant developments of the postwar years was the discovery by Karl Ziegler¹² in Germany of new coordination catalysts for initiating polymerization reactions and the application by Giulio Natta in Italy of these new systems to development of polymers having controlled stereochemistry.¹³ Their work has revolutionized the polymer industry, for these so-called stereoregular polymers have mechanical properties superior in most instances to those of nonstereoregular polymers. The importance of their discoveries was recognized by the award of the Nobel Prize in Chemistry jointly to Ziegler and Natta in 1963. Equally significant was the work of Paul Flory¹⁴ (Nobel Prize 1974), who established a quantitative basis for polymer behavior, whether it be the physical properties of macromolecules in solution or in bulk or such chemical phenomena as crosslinking and chain transfer (concepts to be encountered later in this text).

More recent years have seen a number of important advances in polymer science, which will be elaborated on in this and later chapters. Examples include:

Polymers having excellent thermal and oxidative stability, for use in high-performance aerospace applications

Engineering plastics—polymers designed to replace metals

High-strength aromatic fibers, some based on liquid crystal technology, for use in a variety of applications from tire cord to cables for anchoring oceanic oil-drilling platforms

Nonflammable polymers, including some that emit a minimum of smoke or toxic fumes

Degradable polymers, which not only help reduce the volume of unsightly plastics waste but also allow controlled release of drugs or agricultural chemicals

Polymers for a broad spectrum of medical applications, from degradable sutures to artificial organs

Conducting polymers—polymers that exhibit electrical conductivities comparable to those of metals

Polymers that serve as insoluble supports for catalysts or for automated protein or nucleic acid synthesis (Bruce Merrifield, who originated solid-phase protein synthesis, was awarded the Nobel Prize in Chemistry in 1984)

This list, by no means exhaustive, clearly illustrates that polymer chemistry is an exciting field with almost limitless possibilities.

1.2 Definitions

As already mentioned, the term *polymer* refers to large molecules—macromolecules—whose structure depends on the monomer or monomers used in their preparation. If only a few monomer units are joined together, the resulting low-molecular-weight polymer is called an *oligomer* (Greek *oligos*, “few”). The structural unit enclosed by brackets or parentheses is

referred to as the *repeating unit* (or *monomeric unit*). One might reasonably argue that the first repeating unit shown previously is $-\text{CH}_2-$ rather than $-\text{CH}_2\text{CH}_2-$; however, it is more conventional to define repeating units in terms of monomer structure. The *smallest* possible repeating unit ($-\text{CH}_2-$ in this instance) is referred to as the *base unit*.

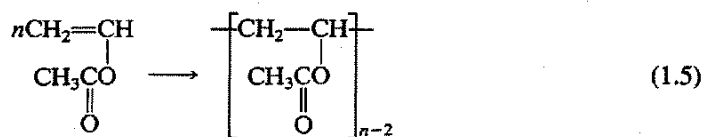
End groups are the structural units that terminate polymer chains. Where end groups are specified, they are shown outside the brackets, for example,



Some polymers are deliberately synthesized with reactive end groups for undergoing further reaction. Polymers containing reactive end groups are called *telechelic polymers* (from the Greek *tele*, far, and *chele*, claw). Related to telechelic polymers are the commercially important *reactive oligomers*, which are oligomers containing end groups capable of undergoing polymerization, usually by heating, to form network polymers.

Polymers formed by alkene addition reactions are called *homochain* polymers because the polymer chain, or *backbone*, as it is commonly called, consists of a single atom type—carbon—with other atoms or groups of atoms attached. *Heterochain* polymers such as polyethers or polyesters contain more than one atom type in the backbone.

The *degree of polymerization* (DP) refers to the total number of structural units, including end groups, and hence is related to both chain length and molecular weight. Consider, for example, the polymerization of vinyl acetate (an important industrial monomer) in reaction (1.5):



DP in this case is equivalent to n (note that two monomer units are at the chain ends), and the molecular weight of the macromolecule is the product of DP and the molecular weight of the structural unit. For a DP of 500, for example,

$$\text{Molecular weight} = 500 \times 86 = 43,000$$

Because polymer chains within a given polymer sample are almost always of varying lengths (except for certain natural polymers like proteins), we normally refer to the *average degree of polymerization* (DP).

A polymer prepared from a single monomer is called a *homopolymer*. If two or more monomers are employed, the product is a *copolymer*. In copolymers the monomeric units may be distributed randomly (*random copolymer*), in alternating fashion (*alternating copolymer*), or in blocks (*block copolymer*). A *graft copolymer* consists of one polymer branching from the backbone of the other. These various possibilities are illustrated schematically in Figure 1.1 for hypothetical monomers A and B. There are different kinds of block copolymers. Where blocks of A and B alternate in the backbone, the polymer is designated an $-\text{AB}-$ *multiblock* copolymer. If the backbone consists of a single block of each, it is an *AB diblock* copolymer. Other possibilities include *ABA* (*triblock*: a central B block with terminal A blocks) and *ABC* (*triblock*: one each of three different blocks). As will be seen later, certain monomer combinations display a tendency toward alternation during copolymerization, whereas formation of block and graft copolymers requires special techniques. Polyesters

-A-A-A-A-A-A-A-	Homopolymer
-A-B-B-A-B-A-A-B-	Random copolymer
-A-B-A-B-A-B-A-B-	Alternating copolymer
-A-A-A-A-B-B-B-B-	Block copolymer
-A-A-A-A-A-A-A- B-B-B-B-B-B-	Graft copolymer

FIGURE 1.1. Representations of homopolymer and copolymers.

of the type shown in equation (1.4) may also be considered copolymers, since two monomers, dibasic acid and glycol, are employed in the synthesis. More commonly, however, the term *copolymer* is reserved for polymers having more than one kind of repeating unit—for example, a *copolyester* prepared from two different dibasic acids and a glycol.

One can also describe polymers as *linear*, *branched*, and *network* (Figure 1.2). A linear polymer has no branching other than the pendant groups associated with the monomer. Graft copolymers, on the other hand, are examples of branched polymers. It should be stressed, however, that a branched polymer is not necessarily a graft copolymer. Low-density polyethylene (discussed later) is a common example of a branched homopolymer whereby chain branching arises as a result of side reactions during the polymerization process.

Some more unusual polymer architectures are represented in Figure 1.3. *Star polymers* contain three or more polymer chains emanating from a core structural unit. *Comb polymers*

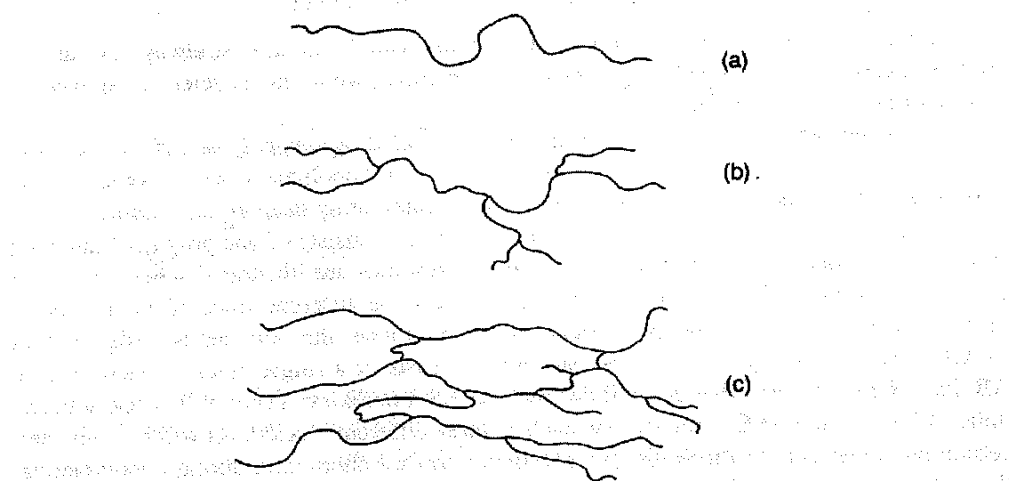


FIGURE 1.2. Representation of polymer types: (a) linear, (b) branched, and (c) network.

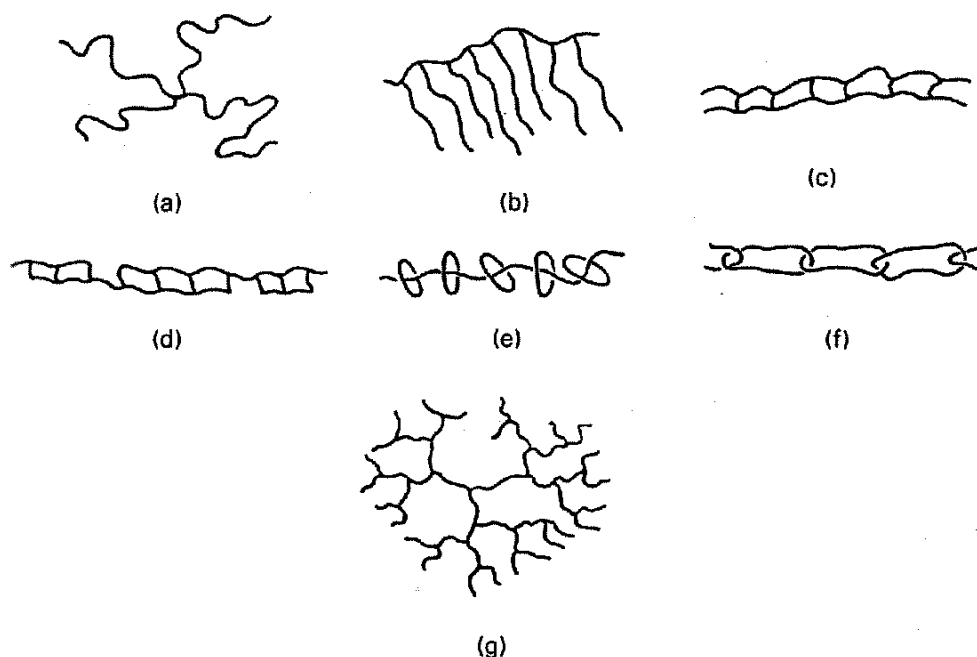


FIGURE 1.3. Representations of (a) star polymer; (b) comb polymer; (c) ladder polymer; (d) semi-ladder (or stepladder) polymer; (e) polyrotaxane; (f) polycatenane; (g) dendrimer.

contain pendant chains (which may or may not be of equal length) and are related structurally to graft copolymers. Such a polymer may be synthesized by polymerizing a long-chain vinyl monomer, or even by polymerizing an existing polymer (or oligomer) containing a polymerizable double bond at the end of the chain (reaction 1.6). Such polymeric or oligomeric monomers are termed *macromonomers* or *macromers*.



Ladder polymers are made up of recurring fused-ring structures, whereas *semiladder* or *step-ladder polymers* have fused-ring sections interspersed with open-chain units. Polyrotaxanes and polycatenanes¹⁵⁻¹⁷ are examples of *supramolecular assemblies*—molecules linked intermolecularly by noncovalent bonding. The former consist of polymer chains (or polymer side chains) threaded through cyclic compounds,¹⁸ while the latter are made up of interlocking rings.¹⁹ *Dendrimers*,²⁰⁻²² also known as dendritic, Starburst (a Michigan Molecular Institute trademark), or cascade polymers, resemble star polymers except that each leg of the star exhibits repetitive branching in the manner of a tree (Greek *dendron*, tree). Certain extremely branched polymers, termed *hyperbranched polymers*, are related to dendrimers in that they exhibit dendritic branching, but the branches do not emanate from a central core, nor is the branching necessarily regular as it is in dendrimers. Dendrimers, hyper-

lymer

copolymer

ymer

ymer

lymers, since two monomers, commonly, however, the term of repeating unit—for ex- and a glycol.

etwork (Figure 1.2). A linear ated with the monomer. Graft ymers. It should be stressed, opolymer. Low-density poly- homopolymer whereby chain arization process.

in Figure 1.3. *Star polymers* ructural unit. *Comb polymers*

(a)

(b)

(c)

1, and (c) network.

branched polymers, and supramolecular assemblies represent new and rapidly developing areas of polymer chemistry with potentially useful industrial applications.^{23, 24}

Network polymers are formed when linear or branched polymer chains are joined together by covalent bonds, a process called *crosslinking*. Vulcanization of rubber (discussed in Chapter 9) is an example of crosslinking. Network polymers are also formed from polyfunctional monomers. If ethylene glycol in reaction (1.4) is replaced with the triol glycerol, for example, a network polyester is formed. Because of crosslinking, the polymer chains of network polymers lose their ability to flow past one another. As a result the polymer will not melt or flow and cannot, therefore, be molded. Such polymers are said to be *thermosetting* or *thermoset*. To manufacture useful articles out of thermosetting polymers, one must accomplish the crosslinking reaction in place or temporarily disrupt the crosslinking to allow the polymer to flow. Thermosetting polymers are also insoluble because the crosslinking causes a tremendous increase in molecular weight. At most, thermosetting polymers only swell in the presence of solvent, as solvent molecules penetrate the network. It is interesting to reflect that an article made with a thermosetting polymer may be considered one gigantic molecule if one can believe that all polymer chains present are linked together!

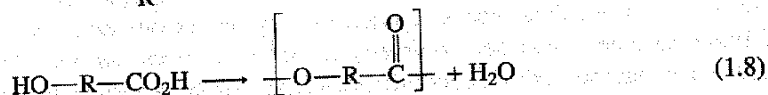
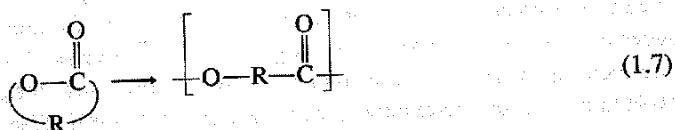
Polymers that are not crosslinked (linear or branched) can usually be dissolved in some solvent, and in most instances they will melt and flow. Such materials are said to be *thermoplastic*.

Polymers may also be categorized according to physical or mechanical properties or end use into *plastics*, *fibers*, *rubbers* (*elastomers*), *coatings*, and *adhesives*. These classifications are discussed in Section 1.8.

1.3 Polymerization Processes

Traditionally, polymers have been classified into two main groups, *addition polymers* and *condensation polymers*. This classification, first proposed by Carothers,²⁵ is based on whether the repeating unit of the polymer contains the same atoms as the monomer. An addition polymer has the same atoms as the monomer in its repeating unit, whereas condensation polymers contain fewer because of the formation of byproducts during the polymerization process. The corresponding polymerization processes would then be called addition polymerization and condensation polymerization. Labeling a given polymer as the addition or condensation type is complicated, however, by the fact that the polymer might well be synthesized by either addition or condensation polymerization or by ring opening. The formation of polyether from both ethylene oxide and ethylene glycol, described earlier, is one example. Other examples are shown in reactions (1.7)–(1.14):

1. Polyester from lactone (1.7), and from ω -hydroxycarboxylic acid (1.8):



Hawley's
Condensed Chemical
Dictionary

THIRTEENTH EDITION

Revised by
Richard J. Lewis, Sr.



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oil gas. A gas made by the reaction of steam at high temperature on gas oil or similar fractions of petroleum, or by high-temperature cracking of gas oil. One typical analysis is heating value 554 Btu/ft³, illuminants 4.2%, carbon monoxide 10.4%, hydrogen 47.6%, methane 27.0%, carbon dioxide 4.6%, oxygen 0.4%, nitrogen 5.8%, autoign temp 637F (336C).

Hazard: Flammable, dangerous fire and explosion risk. Toxic by inhalation.

oiliness. That property of a lubricant that causes a difference in coefficient of friction when all the known factors except the lubricant itself are the same. This concept is also expressed by the term *lubricity*.

oil of bitter almond. See almond oil.

oil of mirbane. See nitrobenzene.

oil of vitriol. See sulfuric acid.

oil of wintergreen. See methyl salicylate.

oil sands. (tar sands). Porous sandstone structures occurring on the surface and to depths of 100 m or more in certain localities; they contain a high proportion of bitumen composed chiefly of asphaltenes and maltha, together with substantial percentage of sulfur and heavy metals. Its viscosity is about midway between that of crude oil and soft asphalt. The largest deposit in North America is in the Athabasca region of Alberta; there are smaller ones in the western U.S. Venezuela and Trinidad have large deposits. The Athabasca sands have been successfully mined and have made a substantial contribution to Canadian energy resources over the past decade.

oil shale. Extensive sedimentary rock deposits in the mountains of Colorado, Utah, and Wyoming contain a high percentage of kerogen, which can be separated from the shale either by heating in retorts (surface mining) or by direct combustion in situ in interior excavations. The deposits range in thickness from 10 to 800 ft and yield from 25 to 30 gal oil/ton shale. Only 33% of the oil content is recoverable by present techniques.
See shale oil; kerogen.

oil varnish. See varnish.

oil, vulcanized. See factice.

oil white. One of several mixtures of lithopone and white lead or zinc white. It may also contain gypsum, magnesia, whiting, or silica.
Use: White-lead substitute.

ointment. (salve). A semisolid pharmaceutical preparation based on a fatty material such as lanolin

and often containing petrolatum or zinc oxide together with specific medication for relief of rashes and other forms of dermatitis.

oiticica oil.

Derivation: By expression from the seeds of the Brazilian oiticica tree, *Licania rigida*.

Chief constituents: Glycerides of α -licanic acid (4-keto-9,11,13-octadecatrienoic acid).

Use: Drying oil in paints, varnishes, etc.

"Okerin" [Astor]. TM for rubber waxes and paraffin products.

Available forms: Flake, prill, or slab.

Use: To provide controlled migration for ozone protection of rubber.

-ol. A suffix indicating that one or more hydroxyl groups (OH) are present in an organic compound, e.g., alcohol, phenol, menthol. Thiol is an exception, the oxygen of the OH group being replaced by sulfur. There are a few other exceptions among the essential oils, e.g., eucalyptol.

Olah, George A. (1927-). Born in Hungary, now an American citizen, he won the Nobel prize for chemistry in 1994 for his work with carbocations. These are positively charged hydrocarbons with lifetimes on the order of microseconds. Olah developed methods of studying carbocations with different physical techniques, changing the direction of this field. He received a Ph.D. from the Technical University of Budapest in 1949.

oleamide. $\text{cis-CH}_3(\text{CH}_2)_7\text{CH:CH}(\text{CH}_2)_7\text{CONH}_2$.

Properties: Ivory-colored powder. Mp 72C, d 0.94. Combustible.

Grade: Refined.

Use: Slip agent for extrusion of polyethylene, wax additive, ink additive.

oleate. Salt made up of a metal or alkaloid with oleic acid. It is used for external medications and in soaps and paints.

olefin. (alkene). A class of unsaturated aliphatic hydrocarbons having one or more double bonds, obtained by cracking naphtha or other petroleum fractions at high temperatures (1500-1700F). Those containing one double bond are called alkenes, and those with two are called alkadienes, or diolefins. They are named after the corresponding paraffins by adding *-ene* or *-ylene* to the stem. α -olefins are particularly reactive because the double bond is on the first carbon. Examples are 1-octene and 1-octadecene, which are used as the starting point for medium-biodegradable surfactants. Other olefins (ethylene, propylene, etc.) are starting points for certain manufactured fibers.
See diolefin.

olefin fiber. Synthetic long-chain polymer fiber composed of at least 85% by weight of ethylene, propylene, or other crystalline polyolefins.

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AN ENCYCLOPEDIA OF
CHEMICALS, DRUGS, AND BIOLOGICALS

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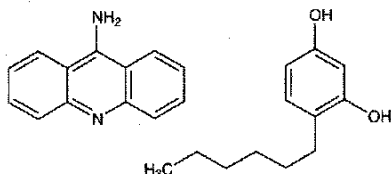
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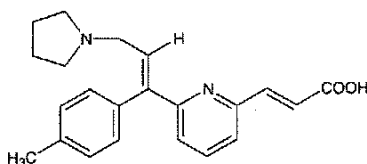
128. Acrisorcin. [7527-91-5] 4-Hexyl-1,3-benzenediol compd with 9-acridinamine (1:1); 9-aminoacridine compd with 4-hexylresorcinol; 9-aminoacridinium 4-hexylresorcinolate; Sch-7056; Akirinol. $C_{25}H_{28}N_2O_2$; mol wt 388.50. C 77.29%, H 7.26%, N 7.21%, O 8.24%. Prep'd from 9-aminoacridine and 4-hexylresorcinol: Seneca, *Antibiot. & Chemother.* **11**, 587 (1961).



Yellow crystals.

THERAP CAT: Antifungal.

129. Acrivastine. [87848-99-5] (2E)-3-[6-[(1E)-1-(4-Methylphenyl)-3-(1-pyrrolidinyl)-1-propenyl]-2-pyridinyl]-2-pyridineacetic acid; (E)-6-[(E)-3-(1-pyrrolidinyl)-1-p-tolylpropenyl]-2-pyridineacetic acid; BW-270C; BW-825C; BW-A825C; Semprex. $C_{25}H_{24}N_4O_2$; mol wt 348.44. C 75.83%, H 6.94%, N 8.04%, O 9.18%. Nonsedating type histamine H_1 -receptor antagonist; analog of triprolidine, *q.v.* Prepn: G. G. Coker, J. W. A. Findlay, EP 85959 (1983 to Wellcome); J. W. A. Findlay, G. G. Coker, US 4501893 (1985). Pharmacodynamics and pharmacokinetics in humans: A. F. Cohen *et al.*, *Eur. J. Clin. Pharmacol.* **28**, 197 (1985). Evaluation of CNS effects: A. F. Cohen *et al.*, *Clin. Pharmacol. Ther.* **38**, 381 (1985). Clinical trials in idiopathic urticaria: J. G. Gibson *et al.*, *Dermatologica* **169**, 179 (1984); H. Neittaanmaki *et al.*, *ibid.* **177**, 98 (1988); in allergic rhinitis: T. G. Gibbs *et al.*, *J. Int. Med. Res.* **16**, 413 (1988). Review of pharmacology and therapeutic efficacy: R. N. Brogden, D. McTavish, *Drugs* **41**, 927-940 (1991).



Crystals from isopropanol, mp 222° (dec).

Combination with pseudoephedrine, *Duact*.

THERAP CAT: Antihistaminic.

130. Acrolein. [107-02-8] 2-Propenal; acrylic aldehyde; acrylaldehyde; acraldehyde; Aqualin; Magnacide. C_3H_4O ; mol wt 56.06. C 64.27%, H 7.19%, O 28.54%. $CH_2=CHCHO$. Prep'd industrially by passing glycerol vapors over magnesium sulfate heated to 330-340°. Lab prep'n by heating a mixture of anhyd. glycerol, acid potassium sulfate and potassium sulfate in the presence of a small amount of hydroquinone and distilling in the dark: H. Adkins, W. H. Hartung, *Org. Syn. coll. vol. I*, 15 (1941). Formation from glycerol by the action of *B. amaracrylus*: Voisenet, *Compt. Rend.* **188**, 941, 1271 (1929); by *B. welchii*: Humphreys, *J. Infect. Dis.* **35**, 282; *Chem. Zentr.* **1925**, II, 309. Toxicity study: H. F. Smyth *et al.*, *Arch. Ind. Hyg. Occup. Med.* **4**, 119 (1951). Review: L. G. Hess *et al.*, in *Kirk-Othmer Encyclopedia of Chemical Technology vol. 1* (Wiley-Interscience, New York, 3rd ed., 1978) pp 277-297.

Flammable liquid with pungent odor. mp -88°. d_4^{20} 0.8621; d_4^{30} 0.8389; d_4^{50} 0.8075. bp_{760} 52.5°; bp_{200} 17.5°; bp_{100} +2.5°; bp_{60} -7.5°; bp_{10} -64.5°. n_D^{20} 1.4022. Sol in 2 to 3 parts water; in alcohol, ether. Flash pt, open cup: <0°F (-18°C). Vapor pressure at 20°: 210 mm Hg. Unstable, polymerizes (especially under light or in the presence of alkali or strong acid) forming

disacryl, a plastic solid. Absorption spectrum: Lüthy, *Z. Physik. Chem.* **107**, 291, 298 (1923). LD₅₀ orally in rats: 0.046 g/kg (Smyth).

Caution: Potential symptoms of overexposure are irritation of eyes, skin and mucous membranes; decreased pulmonary function; delayed pulmonary edema; chronic respiratory disease. See *NIOSH Pocket Guide to Chemical Hazards* (DHHS/NIOSH 97-140, 1997) p 6. See also *Clinical Toxicology of Commercial Products*, R. E. Gosselin *et al.*, Eds. (Williams & Wilkins, Baltimore, 5th ed., 1984) Section II, p 186.

USE: Manuf colloidal forms of metals; making plastics, perfumes; warming agent in methyl chloride refrigerant. Has been used in military poison gas mixtures. Used in organic syntheses. Aquatic herbicide.

131. Acrylamide. [79-06-1] 2-Propenamide. C_3H_5NO ; mol wt 71.08. C 50.69%, H 7.09%, N 19.71%, O 22.51%. $CH_2=CHCONH_2$. Prep'd from acrylonitrile by treatment with H_2SO_4 or HCl: Bayer, *Angew. Chem.* **61**, 240 (1949); Weisgerber, US 2535245 (1950 to Hercules). Reviews: Carpenter, Davis, *J. Appl. Chem. (London)* **7**, 671 (1957); C. E. Habermann in *Kirk-Othmer, Encyclopedia of Chemical Technology vol. 1* (John Wiley & Sons, New York, 4th ed., 1991) pp 251-266. Toxicity: R. E. Peterson, N. K. Sheth, *Toxicol. Appl. Pharmacol.* **33**, 142 (1975). Review of carcinogenic risk: *IARC Monographs* **60**, 389-433 (1994).

Monomer, flake-like crystals from benzene. d_4^{20} 1.122, mp 84.5°. bp_2 87°; bp_3 103°; bp_{25} 125°. Solubilities in g/100 ml solvent at 30°: water 215.5; methanol 155; ethanol 86.2; acetone 63.1; ethyl acetate 12.6; chloroform 2.66; benzene 0.346; heptane 0.0068. The solid may be stored in a cool, dark place. Readily polymerizes at the mp or under uv light. Commercial solns of the monomer may be stabilized with hydroquinone, *tert*-butylpyrocatechol, *N*-phenyl-2-naphthylamine or other antioxidants. LD₅₀ i.p. in mice: 170 mg/kg (Peterson, Sheth).

Polymer. Various forms, sol and insol in water, are obtained by heating with various polymerization catalysts: C. E. Schildknecht, *Vinyl and Related Polymers* (Wiley, New York, 1952) pp 314-322; D. Lipp, J. Kozakiewicz in *Kirk-Othmer, Encyclopedia of Chemical Technology vol. 1* (John Wiley & Sons, New York, 4th ed., 1991) pp 266-287.

Caution: Potential symptoms of overexposure to the monomer are ataxia, numbness of limbs, paresthesia; muscle weakness; absence of deep tendon reflex; sweating of hands; fatigue; lethargy; irritation of eyes and skin; reproductive effects. See *NIOSH Pocket Guide to Chemical Hazards* (DHHS/NIOSH 97-140, 1997) p 6. Readily absorbed through intact skin from aqueous solutions. See *Clinical Toxicology of Commercial Products*, R. E. Gosselin *et al.*, Eds. (Williams & Wilkins, Baltimore, 5th ed., 1984) Section II, p 409. This substance is reasonably anticipated to be a human carcinogen: *Ninth Report on Carcinogens* (PB2000-107509, 2000) p III-67.

USE: Monomer as chemical intermediate in production of polyacrylamides; in synthesis of dyes; in copolymers for contact lenses; in construction of dam foundations, tunnels and sewers. Polymers as additives for water treatment, enhanced oil recovery, flocculants, papermaking aids, thickeners, soil conditioning agents, sewage and waste treatment, ore processing, permanent-press fabrics.

132. Acrylic Acid. [79-10-7] 2-Propenoic acid; vinyl formic acid. $C_3H_4O_2$; mol wt 72.06. C 50.00%, H 5.59%, O 44.41%. $CH_2=CHCO_2H$. Prep'd by hydrolysis of acrylonitrile: Kaszuba, *J. Am. Chem. Soc.* **67**, 1227 (1945); by oxidation of acrolein: US 1911219 (1933 to Rohm & Haas); US 2288566 (1942 to Acrolein Corp.); US 2341339 (1944 to Distillers). Various other syntheses, see *Org. Syn. coll. vol. III*, 30-34 (1955). Toxicity study: H. F. Smyth *et al.*, *Am. Ind. Hyg. Assoc. J.* **23**, 95 (1962). Review: J. W. Nemec, W. Bauer in *Kirk-Othmer Encyclopedia of Chemical Technology vol. 1* (Wiley-Interscience, New York, 3rd ed., 1978) pp 330-354.

Corrosive liquid; acid odor and fumes. d_4^{16} 1.0621, mp 14°; $bp_{141.0}$ 122.0°; bp_{200} 103.3°; bp_{100} 86.1°; bp_{40} 66.2°; bp_{10} 39.0°; bp_3 27.3°. n_D^{20} 1.4224. Flash pt, open cup: 155° (68°C). pKa (25°): 4.25. Miscible with water, alc, ether. Po